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Monterey, California

ON THE COMPARATIVE COSTING
OF MILITARY vs CIVILIAN MODES
OF HEALTH CARE DELIVERY

by

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and

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The military services of the United States maintain an extensive health care delivery system in order to ensure the appropriate level and availability of care to the active duty forces. If only the active duty personnel were to use these facilities they would operate at only a fraction of that possible given the necessity to staff for the military contingency plans. Thus, given the expansion of the health care

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20. fringe benefit package of the active duty and retired personnel, the non-active duty population for whose care the military become responsible in one form or another have been allowed, and sometimes urged to utilize at least a portion of this excess system capacity.

The end of the draft and the resulting need to compete in the marketplace for medical personnel, as well as the general inflation in the health care sector, has spotlighted the increasing cost of caring for these dependent groups. The question has arisen of whether it might not be cheaper to shift some of this demand for health care to the civilian sector.

In this paper we examine analytically the appropriate considerations and elements to be compared in this research point out the crucial empirical work necessary to estimate such a model, discover some of the ways in which the analytical construct can provide bounds and directions to the hypotheses to be tested, and finally conjecture some preliminary policy recommendations.

Executive Summary

At a time when one of the major socio-economic problems facing the nation is the demand for more equitable access to a health care delivery system which continues to be characterized by a rate of inflation greater than the overall level, and when the Surgeon's General of the three major military services are diligently searching for the least-cost method of providing the care demanded by the eligible population (which is now estimated at around 9 million people), the necessity for minimizing the number of the scarce health care inputs devoted to military-related health industry is painfully obvious.

The military services of the United States maintain an extensive health care delivery system in order to ensure the appropriate level and availability of care to the active duty forces. If only the active duty personnel were to use these facilities they would operate at only a fraction of that possible given the necessity to staff for the military contingency plans. Thus, given the expansion of the health care fringe benefit package of the active duty and retired personnel, the non-active duty population for whose care the military become responsible in one form or another have been allowed, and sometimes urged to utilize at least a portion of this excess system capacity.

The end of the draft and the resulting need to compete in the marketplace for medical personnel, as well as the general inflation in the health care sector, has spotlighted the increasing cost of caring for these dependent groups. The question has arisen of whether it might not be cheaper to shift some of this demand for health care to the civilian sector.

In this paper we examine analytically the appropriate considerations and elements to be compared in this research point out the crucial empirical work necessary to estimate such a model, discover some of the ways in which the analytical construct can provide bounds and directions to the hypotheses to be tested, and finally conjecture some preliminary policy recommendations.

A simple analytical model incorporating the most salient features of the components affecting the comparative costs of providing in-patient care to the eligible non-active duty population in either military or civilian hospitals was constructed. The model was used to indicate the four types of empirical research on a regional basis necessary to provide a truly minimum cost solution to the government's problem of providing the promised historical level of care to an ever growing number of eligible beneficiaries.

These include:

(1) Derivation of the <u>true</u> fixed and variable cost functions for <u>each</u> regional military health care facility.

(2) The non-active-duty demand for care at the <u>military</u> facility especially in terms of its sensitivity to "space-available" and prices of civilian care.

(3) The analogous demand for care in the private sector in each region.

(4) The regional private sector cost functions and thus the potential impact of a shift from the military sector.

Further, though the analytical model we demonstrate the fallacy of using historical regional costs for incremental (positive or negative)

utilization impact assessment and show that it may be relatively simple to satisfy conditions which call for less than "full capacity," or more than "minimum staffing capacity," utilization by the dependent population of the military facility.

I. INTRODUCTION.

The military services of the United States maintain an extensive health care delivery system in order to ensure the most appropriate and timely care of the members of the active duty armed forces. Such a system must be prepared to deliver the level of curative and restorative care necessitated by an armed struggle anywhere in the world. Thus since at most instances in time the country is at peace, or at least not engaged in full-scale wars, the health care delivery system operates on the average at much less than its capacity.

The historical recognition of this fact and the desire to provide the maximum number of attractive fringe benefits to active duty personnel to encourage (re)enlistment led to the allowance for dependent-utilization of military health care facilities on a "space-available" basis. The rationale was that since the physical facilities existed due to contingency requirements for the active duty forces and had excess capacity, and since the personnel to staff the facility could be obtained at less than market prices through the use of the draft, the marginal cost of providing dependent care would be minimized in this mode of delivery.

The extension of the scope of the dependent care program under CHAMPUS (the Civilian Health and Medical Program of the Uniformed Services) and its associated potential costs in the private health delivery sector added impetus to the desire to "produce" as much of the desired health care as possible "in house" - i.e., in military medical facilities and using military health care personnel. This

lead to the estimation and inclusion of non-active duty demands for care when new military health facilities were being built. Thus the physical size of many military hospitals tended to be larger than that strictly necessary to meet contingency requirements.

The loss of the draft for both fighting force personnel and the physicians and other medical staff necessary to operate military medical care facilities, has been the immediate impetus to a rather careful scrutiny of the costs and advisability of the continuing military health care program.[1] One of the major objectives has been to identify not only the total costs of delivering care in the military delivery system to the eligible population, but especially to rigorously derive the marginal costs associated with providing health care to the various non-active duty eligibles--dependents of active duty personnel, retired military personnel, their dependents, and survivors and dependents of military personnel.

It has been suggested in many quarters that perhaps the way to minimize the total cost of providing health care to all groups is to "shift" some care responsibilities to the private sector. In this paper we examine analytically the appropriate considerations and elements to be compared in such a situation, point out the crucial empirical work necessary to estimate such a model (and which estimates are lacking in our view), discover some of the ways in which the analytical construct can provide bounds and direction to the hypotheses

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[1] See, for example, the "Boeing Study" [1]. A combined task group of OMB/DOD/HEW personnel are also just completing their study. A Navy-specific study of the future of its health care system is also underway.

to be tested empirically, and finally conjecture some preliminary policy recommendations which may result.

We have chosen to confine our analysis to the use of inpatient facilities and to emphasize a fairly standard method of graphical analysis in order to highlight the expository nature of this work. We believe, and attempt to point out in the concluding section, that the ramifications of the analysis for the ambulatory care sector are easily derived by extension and slight modification of the present model.

Additionally, we have chosen to disaggregate the analysis to the regional level because of the well known differences which exist between various geographical areas of the country (in terms of facility quality and availability, demographic utilization rates, etc.).

We confine the scope of our analysis throughout to the question of finding the least cost method of providing health care to the eligible population as presently configured. That is, we do not address the possibility of completely disenfranchising any group of present beneficiaries or drastically changing the structure of the CHAMPUS program. Such monumental policy decisions have large potential inpact on the whole recruiting and retention picture and thus would involve such significant spillover costs that a much broader based model would be required.

II. AN ILLUSTRATIVE GRAPHICAL MODEL

In this section, we will introduce a very simple graphical model of the costs to the government of utilization of the military and civilian health care delivery system. At this point, we will not attempt to describe the exact nature of the functions associated with the various cost components, preferring to sacrifice details for the clarity of presentation of the major elements of the model. In Section III, more realism and rigor will be introduced.

First, we will examine the relationship between physical size of a given military hospital, its number of "staffed" acute care beds, and the actual utilization of the facility.

For any given military facility, there exists a maximum bed size which implies a maximum possible number of staffed beds that we will denote by x_M. Likewise, we denote a minimum staffed level of beds by x_m, $x_m \varepsilon [0,x_M]$. This of course, relates to the real possibility that "contingency staffing" requirements may play an important role in the operation of the particular facility. We posit that the total "periodic fixed costs", c_f, of operating the facility are dependent on the physical size, the number of staffed beds, x, and the expected case-mix of the facility, α. Thus, we have:

$$c_f = c_f(x,\alpha) \qquad x \varepsilon [x_m,x_M] \tag{1}$$

$$\frac{\partial c_f}{\partial x} = c_f' > 0, \quad \frac{\partial c_f}{\partial \alpha} > 0$$

where the physical size variable is subsumed in the functional form and α is a direct measure of the difficulty of the expected case

load.* Next, consider the variable cost, c_v, of operating the facility. This will depend on both the level of operation for which it is staffed, x, and the utilization of the facility, y.

$$c_v = c_v(x,y) \qquad (2)$$

$$\text{with} \qquad \frac{\partial c_v}{\partial x} \leq 0$$

$$\text{and} \qquad \frac{\partial c_v}{\partial y} \equiv c_v' > 0$$

$$\text{with} \quad c_v'(y \leq x) \leq c_v'(y > x) \quad \forall\, x \leq x_M$$

Finally then, the total cost of operating the military facility is given by $\mathcal{L}$:

$$\mathcal{L}(x,y,\alpha) = c_v(x,y) + c_f(x,\alpha) \qquad (3)$$

We picture the individual relationships in Figure 1 utilizing a linearity assumption for the present expository purposes.

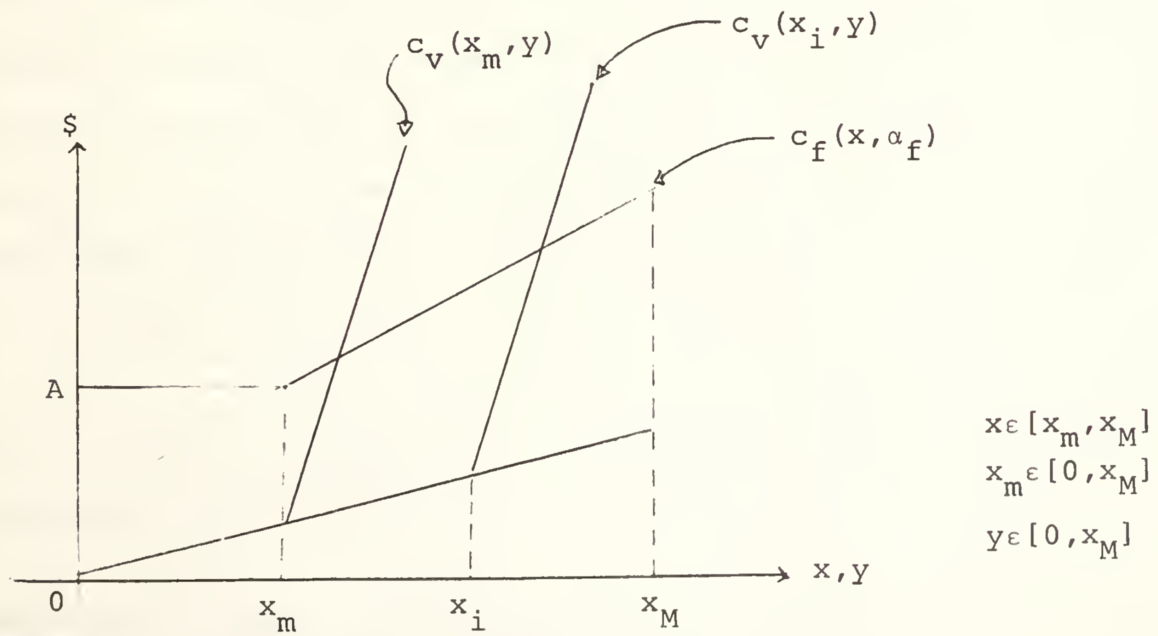

FIGURE 1

*Thus, the measure of the expected case-mix for a facility where open heart survery was performed would be larger than for the same institution where it was not, ceteris paribus, since the staffing would of necessity, be different, as would the amount of capital equipment necessary.

Using the linearity assumptions we specify:

$$c_f = A + \beta_0(x-x_m) \qquad x\varepsilon[x_m,x_M] \tag{1'}$$

$$c_v = \begin{cases} \beta_1 y & y\varepsilon[0,x] \\ \beta_1 x + \beta_2(y-x) & y\varepsilon(x,x_M) \end{cases} \tag{2'}$$

Thus, because of the cost of staffing beds even if not used, the total fixed costs rise (here at constant rate) after satisfying the minimum requirement of x_m, such that the distance 0A represents what is normally considered as fixed costs in production theory. The residual $c_f - A$ for any given staffing level represents the cost of that particular level of staffing in excess of x_m.

Likewise, the variable cost curve is segmented. This stems from the fact that for any utilization level less than or equal to the level for which the hospital is already staffed, the incremental costs are relatively much less than for those utilization levels <u>above</u> the staffed level. This, of course, is due to the need to increase personnel and associated supplies as well as the "usual" variable costs incurred as patient load increases from below the staffed level. As the staffed level increases, the "kink" or increasing rate segment of c_v shifts "out".

Naturally, as the increase in x causes c_v to fall, c_f rises.* We can construct a family of total cost curves associated

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*However the absolute value of the increase in c_f must be less than that of the decrease in c_v from the combination of the definitions of fixed and variable costs and the assumption of the consistent choice of the most efficient methods to produce any given level of output.

with varying levels of staffing. This is illustrated in Figure 2.

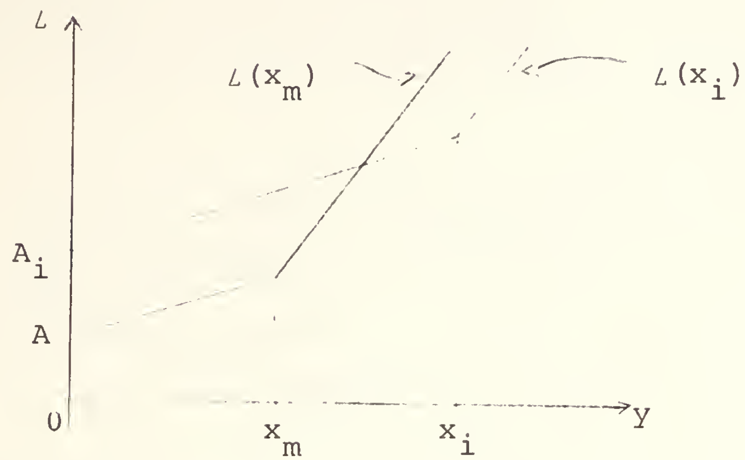

Figure 2

$$L(x_m) = \begin{cases} A + \beta_1 y & y \le x_m \\ A + \beta_1 x_m + \beta_2 (y - x_m) & y > x_m \end{cases} \qquad (3)'$$

$$L(x_i) = \begin{cases} A_i + \beta_1 y & y \le x_i \\ A_i + \beta_1 x_i + \beta_2 (y - x_i) & y > x_i \end{cases}$$

where $$A_i = A + \beta_0 (x_i - x_m)$$

Next, we consider the non-active-duty (NAD) population eligible to use the military facility but who also have the option to use the civilian or private-sector health care delivery system. For the moment we group all dependents, of active duty and retired personnel, and the retired military, from the various services together. We shall subsequently note and discuss the effect of considering each group independently.

It is clear that the NAD demand for care in the military or the civilian system is affected by both monetary and non-monetary factors.

For the purposes of this paper, we will restrict our examination to the combination of the direct monetary cost and the time cost to the patient borne due to queueing at the military facility.* We thus assume that the care delivered in the alternative systems is of comparable quality.

If we let "p" be the average gross price per unit of private sector care, β be the patient's coinsurance rate under the CHAMPUS program for NAD personnel, and let b denote a measure of the comprehensiveness of the coverage under CHAMPUS, then the total NAD demand for military inpatient care, y^1 is given by:

$$y^1 = F(s,p,\beta,b) \tag{4}$$

$$\frac{\partial F}{\partial s} > 0, \quad \frac{\partial F}{\partial p} > 0, \quad \frac{\partial F}{\partial \beta} > 0, \quad \frac{\partial F}{\partial b} < 0$$

where s is the average "space available" for NAD care in the military facility. Thus, s will be a proxy in our model for the waiting time faced by the NAD potential patient in the military facility. If we let y^2 denote the expected utilization of the military facility by the AD population, then recalling that x was the staffing level for the facility yields

$$s = x - y^2 .$$

Assuming that y^2 is exogenously given or known, y^1 can be expressed solely as a function of the staffing level, given the

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*For a discussion of the probable effects on utilization of the patient's perceptions of the relative quality of the medical care delivered in the respective systems, see Harris and Whipple (1975).

existing private sector price and structure of the CHAMPUS program. Further, we make the interim assumption that changes in the level of the NAD private sector demand will not affect the average price they must pay. This is probably not true in at least some regions because of the relative size of the NAD and non-military related sectors, and this possibility will be considered later in the paper. Thus, since β and b are exogenous (to the model) decision parameters we may write

$$y^1 = f(x) \quad \frac{\partial f}{\partial x} \equiv f' \geq 0 \quad x \varepsilon [x_m, x_M]. \tag{5}$$

We next recognize the fact that the usual "demand" for use of military facilities just discussed can be further influenced by policy decisions to limit such use by NAD personnel through various modes of temporary or permanent disenfranchisement. However, since the actual utilization of the military facility by the NAD, y^{1a} cannot exceed the "demand" we have,

$$y^{1a} \varepsilon [0,\ y^1 = f(x)]$$

or

$$y^{1a} = \phi(x;\eta), \quad \frac{\partial y^{1a}}{\partial x} \geq 0, \quad \frac{\partial y^{1a}}{\partial \eta} \geq 0\ , \tag{6}$$

where η is the "access policy" parameter mentioned. For example, a decision to exclude retired dependents as a class from use of the particular facility would coincide with a decrease in η, and a corresponding shortfall of y^{1a} from y^1. Thus, $\phi(x;\eta)$ is a correspondence as illustrated in Figure 3 below. There we have also defined the relationship $\ell(x, y^{1a})$ to represent the cost of operating the military facility in terms of y^{1a} such that

$$L(x, y = y^2 + y^{1a}, \alpha) = \ell(x, y^{1a})\ .$$

Note that in Figure (3.c), the points y_k, $k = m, i, M$, are the maximum NAD utilization or demand for the given staffing levels x_k, $k = m, i, M$, respectively. These are each less than the associated points y_j, $j = 0, 1, 2$, which are the levels of total utilization for which each x_k was the "minimum cost staffing level" derived and presented in Figure 2 above. This stems from the fact that $y^1(x)$ in (3.a) deviates from the 45° line by more than y^2, i.e., that $y^1(\bar{x}) + y^2 < \bar{x}$ for each $\bar{x} \varepsilon [x_m, x_M]$. Very simply this reflects the fact that the direct care demand response of the NAD group to any given level of "space available" in the MH will fall short of that space available. In particular for $x = x_k$ $k = m, i, M$, the shortfall is $y_j - y_k$, $j = 0,1,2$, respectively. This shortfall--or more specifically the response characteristics of the NAD direct care demand function, $y^1(x)$, along with the returns-to-scale of the military facility production function and the relationship between staffing the facility and the required prices of the inputs--i.e., constant, increasing, or decreasing costs--will determine the shape of the direct care cost function, $L(y^{1a})$ which traces the least cost method of caring for each given level of actual utilization, given the "space available" effect. This curve is shown in sector (3.d) of Figure 3.

Next the NAD's realized demand for civilian inpatient care z^1 is given by,

$$z^1 = G(y^{1a}, p, \beta, b) \tag{7}$$

$$\frac{\partial G}{\partial y^{1a}}, \quad \frac{\partial G}{\partial p}, \quad \frac{\partial G}{\partial \beta} \leq 0 \quad \text{and} \quad \frac{\partial G}{\partial b} \geq 0$$

Again, since p, β, and b are exogenously given we have:

$$z^1 = g(y^{1a}) = g\{\phi(x)\} \tag{8}$$

which is depicted in Figure 4 below.

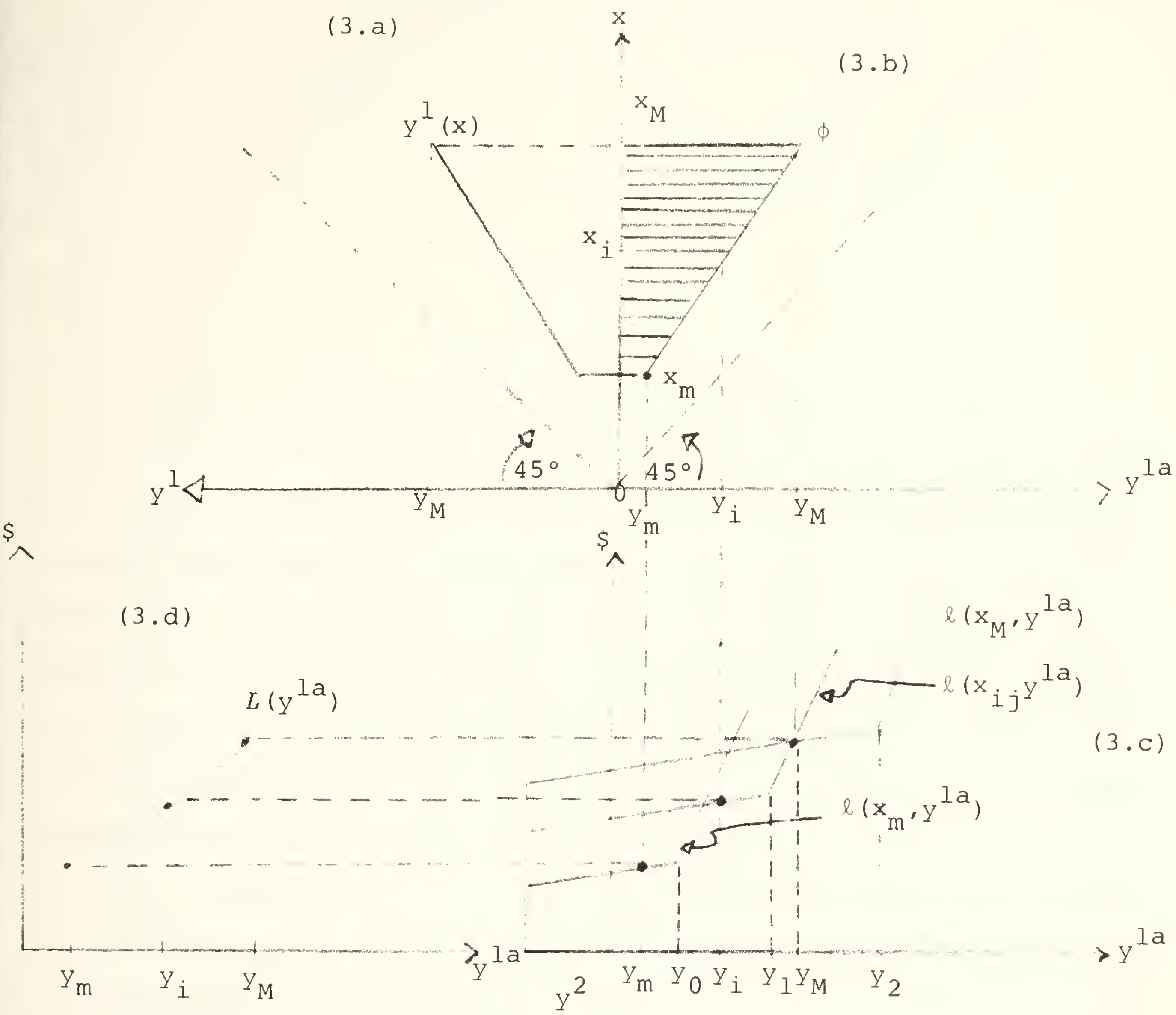
(3.a)
(3.b)
(3.c)
(3.d)
x
x_M
x_i
x_m
$y^1(x)$
ϕ
45°
45°
y^1
y^{la}
y_M
0
y_m
y_i
y_M
\$
\$
$\ell(x_M, y^{la})$
$\ell(x_{ij} y^{la})$
$L(y^{la})$
$\ell(x_m, y^{la})$
y^{la}
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Figure 3

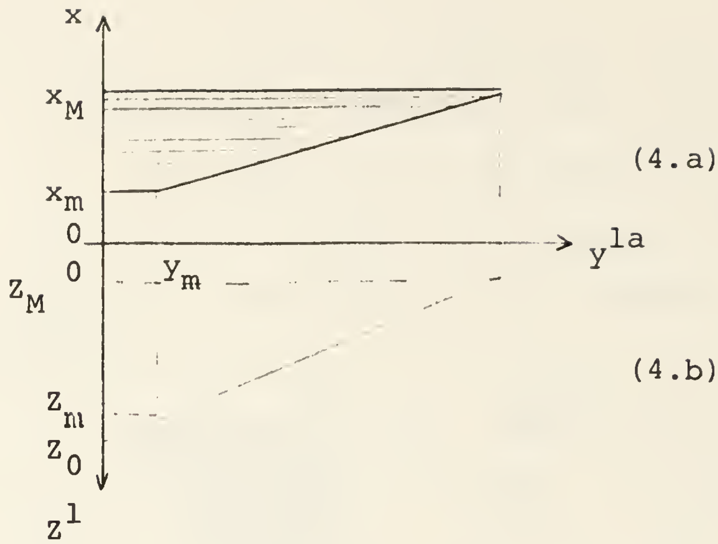

Figure 4

The additional assumptions embodied in Figure 4.b are that there exists a positive demand, z_M, for private sector inpatient care even though the capacity of the military facility is under utilized. This seems to be a realistic position given historical data on CHAMPUS utilization in areas with excess military capacity, and may stem from the geographical location of the patient relative to the facility or bias against military medicine, etc. Also embodied is a relative inelasticity of NAD's demand for civilian care with respect to the military, which reflects the monetary cost born by the NAD in using civilian care. Figure 4.a shows the non-zero usage of the facility by the NAD (i.e., $y_m > 0$) associated with the minimum staff level, which corresponds to the implicit assumption that the expected level of utilization of the facility by the AD is less than the minimum staffing level, i.e., $y^2 < x_m$.

Although the Figure (4.b) is drawn in a linear fashion, it is quite conceivable that kinks or nonlinearities exist. For example, if the cost of civilian care becomes prohibitive to the

family or the facility reaches its capacity, then the reduction in y^{1a} may not cause Z^1 to increase at all resulting in a horizontal segment in the function $Z^1 = g(y^{1a})$.

As the NAD demand for civilian care becomes effective, the military's "contribution" to the total bill through the CHAMPUS program rises (proportionately).* Recalling that Z^1 is the CHAMPUS usage by the NAD population and denoting the usage of the civilian facility by all other groups as Z^2, which for now we assume is uneffected by the level of Z^1, the total cost of civilian facility, N, is expressed as follows

$$N = N(Z^1, Z^2, \gamma) = n(Z^1) \tag{9}$$

where γ is an exogenous parameter representing the type of civilian hospital being utilized as the alternative source of care. For example, γ may be thought of as indicating whether the civilian hospital is proprietary or nonprofit, a comprehensive community-wide facility or one affiliated with a medical school, etc., which effects its cost of operation. If we denote the military 's share of the total cost (CHAMPUS costs) as M then we have

$$M = M(N; p, \beta b) = M\{n(Z^1); p, \beta, b\} \tag{10}$$

We picture these relationships below in Figure 5.

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*Again, at this juncture we are not concerned with the <u>exact</u> nature of the relationship, which may, in fact, vary significantly depending on b and β discussed above, the cost function of the civilian institution, and the pricing structure and institutional relationships between the civilian hospital, its patients and third party payers, etc.

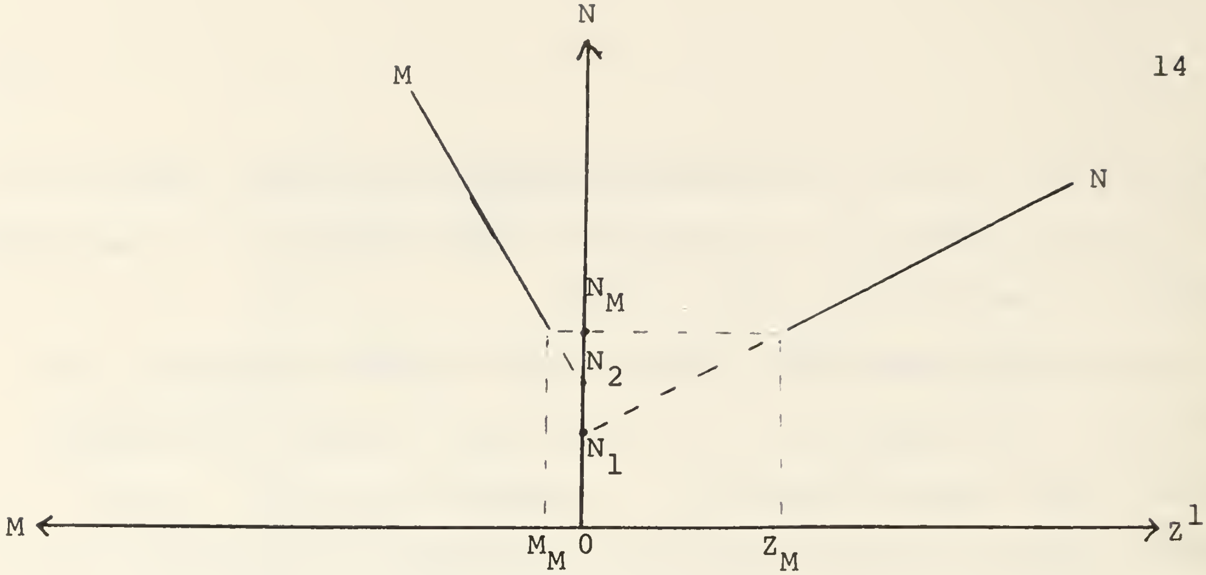

Figure 5

Notice that point N_1 represents the fact that even with <u>no</u> demand for care in the private sector by NAD users, there would be a positive level of cost of operation of the civilian system for civilians only. Additionally, the slope of M is less than 1 since the government only pays a percentage of the costs incurred by NAD people under the CHAMPUS program. And finally, $N_2 > N_1$ to indicate the presence of deductibles and exclusions under the CHAMPUS program.

Finally, we are ready to put the pieces of our model together in a graphical construct so as to facilitate discussion. This is done in Figure 6, where the coincident axes have been joined to form a more compact analytical construct. Since we are concerned with minimizing the "total cost to the government" of providing health care to the eligible population, we are interested in deriving the "total cost curve," call it $c(y^{1a})$. This is done by utilizing the curve $L(y^{1a})$ from Figure 3 above which indicates the cost minimizing level of utilization, $y^{1a}(x)$ for each given level of staffing $\forall\ x \varepsilon [x_m, x_M]$ in combination with the cost of CHAMPUS care as function of y^{1a}, denoted by $M(y^{1a})$. The sum of these two curves yields

$c(y^{la})$. That is, adding $\ell(\bar{y}^{la}) + M(\bar{y}^{la})$, $\forall\ \bar{y}^{la} \in [0, y_M^{la}]$ yields $c(y^{la})$. We then "choose" that level of NAD direct care utilization which minimizes $c(y^{la})$. This is the optimal level of care to be provided in-house, $\hat{y}^{la}$. From Figure 3.b above, we then may determine the optimal staffing level $\hat{x}$ which generates $\hat{y}^{la}$ of utilization. From Figure 6 it is also easy to discover the associated optimal level of NAD CHAMPUS usage $\hat{z}^{l}$, and of course the associated segmented Direct and CHAMPUS optimal cost levels $L(\hat{y}^{la})$ and $M(\hat{y}^{la})$.

It is easy to see that in the case described above $c(y^{la})$ is a linear function of NAD utilization y^{la} such that the optimal strategy will always be to either allow no NAD utilization $(y^{la}(x)=0)$ or to encourage maximum excess capacity facility utilization by the NAD group $(y^{la}(x) = f(x))$. To see this note that if $f(x) = x - y^2$, then $y^{la} \leq f(x) = x - y^2$.

Thus from (3)'

$$L(x) = [A+\beta_0(x-x_m)] + \beta_1 y \qquad \forall\ y \leq x$$

Then $\ell(x,y^{la}) = [A+\beta_0(x-x_m)+\beta_1 y^2] + \beta_1 y^{la} \qquad \forall\ y^{la} \leq x - y^2$

We have $M = M_0 - k \cdot y^{la}$ (see appendix).

Thus
$$c(x,y^{la}) = \ell(x,y^{la}) + M(y^{la})$$

$$= [A+\beta_0(x-x_m)+\beta_1 y^2+M_0] + y^{la}(\beta_1-k)$$

$$\text{for } \forall\ y^{la} \leq x - y^2$$

$$\forall\ x \in [x_m, x_M]$$

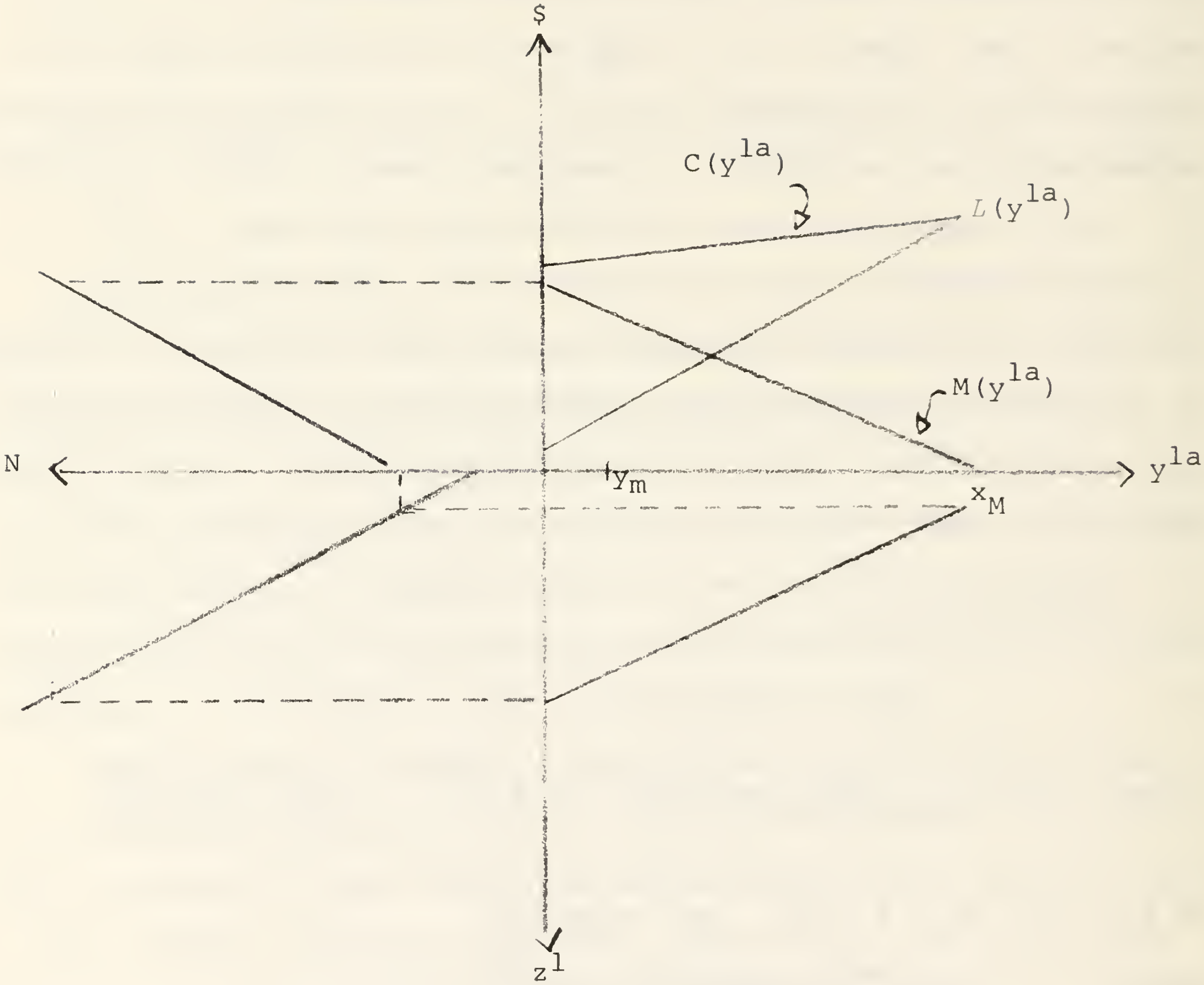

Figure 6

Then for any given x minimization of $c(x, y^{la})$ with respect to y^{la} yields:

$$y^{la}(x) = \begin{cases} 0 & \text{for } \beta_1 > k \\ f(x) = x - y^2 & \beta_1 < k \end{cases}$$

where $y^{la}(x)$ is defined $\ni$ $c[x, y^{la}(x)] \leq c(x, y^{la}) \quad \forall\, y^{la}$.

We may then also define $c(x) \ni$

$$c(x) \equiv c[x, y^{la}(x)]$$

Therefore if we minimize $c(x)$ with respect to the staffing level x, we find:

(i) if $y^{la}(x) = 0$ then $c(x) = A + \beta_0(x - x_m) + \beta_1 y^2 + M_0$

thus the cost minimizing level of staffing is x_m, i.e., $x^* = x_m$ where $x^* \ni c(x^*) \leq c(x) \;\forall\, x$.

(ii) if $y^{la}(x) = f(x)$ then

$$\begin{aligned} (x) &= A + \beta_0(x - x_m) + \beta_1 y^2 + M_0 + f(x)(\beta_1 - k) \\ &= (A - \beta_0 x_m + M_0 + ky^2) + x(\beta_0 + \beta_1 - k) \end{aligned}$$

thus

$$x^* = \begin{cases} x_m & \text{for } \beta_0 + \beta_1 > k \\ x_M & \beta_0 + \beta_1 < k \end{cases}$$

Thus the optimal level of staffing in the linear case shown is at either "boundry"--i.e., equal either to the minimum allowable (x_m) level given contingency requirements if the "marginal cost" of care in the private sector $(k)^*$ is less than the sum of the

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*k is more precisely the rate of change in CHAMPUS costs associated with the change in actual utilization of the military facility. See Appendix 1.

incremental fixed and variable costs $(\beta_0 + \beta_1)$, or to the maximum possible level (x_M) given the size of the facility if the opposite is true. Clearly these are not the most interesting of the possible cases and in the next section a more plausible set of circumstances is examined. However, before moving on it is appropriate to point out the empirical research requirements spotlighted by the foregoing structure and give some indication of the reasons for their importance.

1. The true fixed and variable cost functions for <u>each</u> regional military health care facility with respect to the levels of staffing and utilization must be accurately known in order to derive an estimate of the total inhouse cost of care functions. It is not at all clear that <u>any</u> of these exist at the present time.

2. The NAD demand for care at the <u>military</u> facility and its sensitivity to "space available", price of alternative sources of care, again on a regional basis, is essential to being able to predict the probable effects on utilization of changes in CHAMPUS regulations or expected rates of inflation in the private sector delivery system etc. This, to our knowledge, has been neglected for the most part. In the next section we will demonstrate the possible changes in the method the government chooses to provide care for the eligible population.

3. Next, the NAD demand for care in the <u>private</u> sector in each specific region must be estimated. We emphasize the fact that this is <u>not</u> just the inverse of the demand by NAD eligibles at the military facility. If we know that demand for y_0 of care

in the military facility will be forthcoming at x_0 staffing, and y_1 at x_1 ($x_1 > x_0$, $y_1 > y_0$), this is not sufficient to infer that reducing staff from x_1 to x_0 will shift $y_1 - y_0$ of the demand to the private sector, although it <u>may</u>. The magnitude of this, or other, shifts will depend on the elements we have identified, and their relative magnitudes. This information is sorely lacking at present.

4. Another extremely crucial piece of information is the costliness of the private sector alternatives in the region as a function of NAD demands. For example, if there is one major civilian facility likely to be used by NAD eligibles shifting to the private sector, is it a large teaching hospital (generally the most costly type) operating at the threshold of increasing costs or a fairly new underutilized Health Maintenance Organization (HMO) hospital associated with a prepaid group practice. The different possible answers to this question will produce vastly disparate estimates of the cost of a given NAD population shift for care.

The myriad of possible combinations of "answers" to the estimation questions just posed can result in extremely varied optimal policy recommendations for staffing and utilizing military facilities to treat the NAD eligible population. In the following section we illustrate this position.*

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*We again emphasize that the analytical structure presented in this paper does not address the possible change in military fringe benefits of a strict reduction in the eligible NAD population, but only the decision of whether its best to treat the presently eligible group in military or private facilities.

III. <u>EXAMPLES</u>.

Let us now consider an example which appears more plausible as representative of a situation which might be observed at a particular regional military hospital.

First, suppose that the region is fairly compact so that there are no real geographical barriers to using the military facility MH for care. Thus, the minimum level of CHAMPUS NAD demand is small. Assume that the MH is a relatively new physical plant, built with the total eligible population in mind, and hence that x_M is much larger than the contingency staffing level x_m. Continue the scenario by assuming that the private sector care available is relatively costly, thus tending to make the low-cost (out-of-pocket) MH "attractive." Next suppose that demand for use of the MH increases approximately proportionately with staffing until x_M is approached. Likewise, we posit that even though the gross price of the care available in the local private sector categorizes it as "expensive", the existence of the present CHAMPUS provisions ($25 deductible or a maximum of $3.70 per day, whichever is largest) for hospital and physician coverage yields a net price which is not an extremely effective barrier to the transfer of demand to the private sector as MH staffing levels fall. Additionally, if the civilian hospital is underutilized--e.g., 60% occupancy--while the military hospital generally operates at close to capacity, the combination of a positive incentive toward longer average stays in the civilian hospital and the negative (or at least zero) incentive to keep patients longer than necessary at the MH because of the need for beds, <u>could</u> mean that a given reduction of Δy^{1a} in

utilization of the MH due to a reduction in staffing, Δx, yields an increased NAD utilization of the civilian hospital Δz^1 such that $\Delta z^1 > | \Delta y^{la} |$.* Assuming that full NAD demand for MH direct care is allowed to be effective (i.e., $y^{la} = y^1$) we have, pictorally:

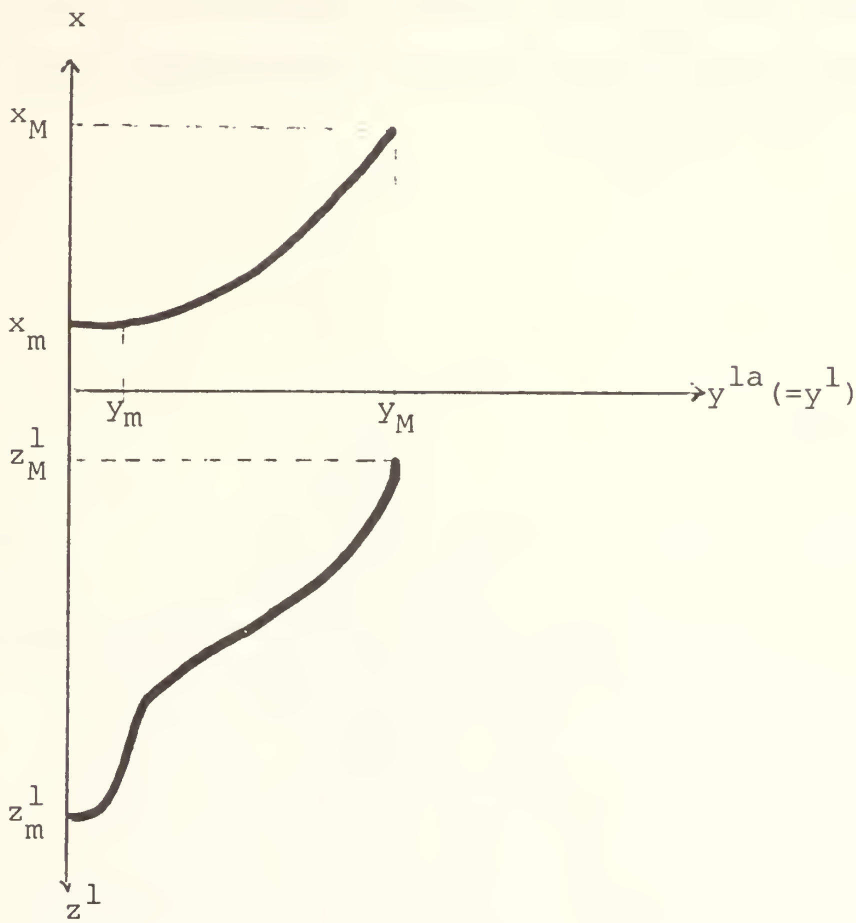

Figure 7

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*This possibility of longer average lengths of stay (LOS) for the "transferred" care is not necessarily inconsistent with the historical LOS comparisons which have shown those in the military facilities generally to be greater than those in the civilian sector hospitals. The argument here would be that the LOS data for the civilian hospitals would tend not to contain the same proportion of more serious (thus requiring longer stays) cases, even controlling for diagnosis, since serious cases would tend to have predictably higher total net prices (including physician fees) in the civilian than the military facilities such that the monetary incentive is relatively strong to have these procedures done under "direct care" rather than CHAMPUS.

Assuming that the civilian hospital sector is in a constant average cost position due to its occupancy factor, with increasing costs only as its capacity is approached, and that the CHAMPUS program remains as historically structured such that average costs to the government tend to rise toward a constant with utilization,* we derive the qualitative picture of the CHAMPUS cost function $M(y^{1a})$ shown in Figure 8 below.

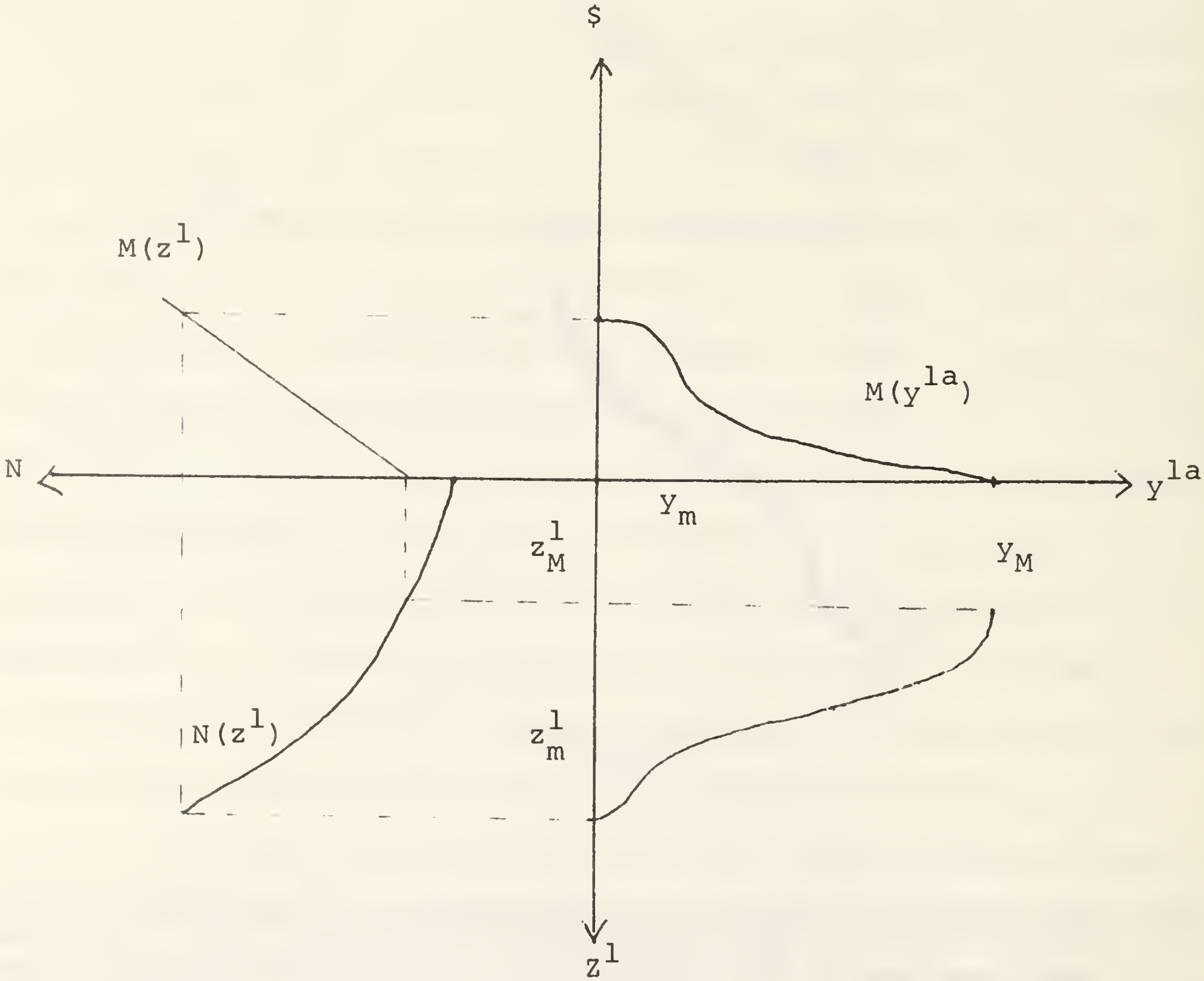

Figure 8

*This is due to the fact that as deductibles are fulfilled the percentage of the total bill paid by the consumed falls.

Using a constant cost assumption for the production of care in the MH and incorporating our assumption regarding the properties of $y^1(x)$ we may derive the direct care cost function $L(y^{la})$.

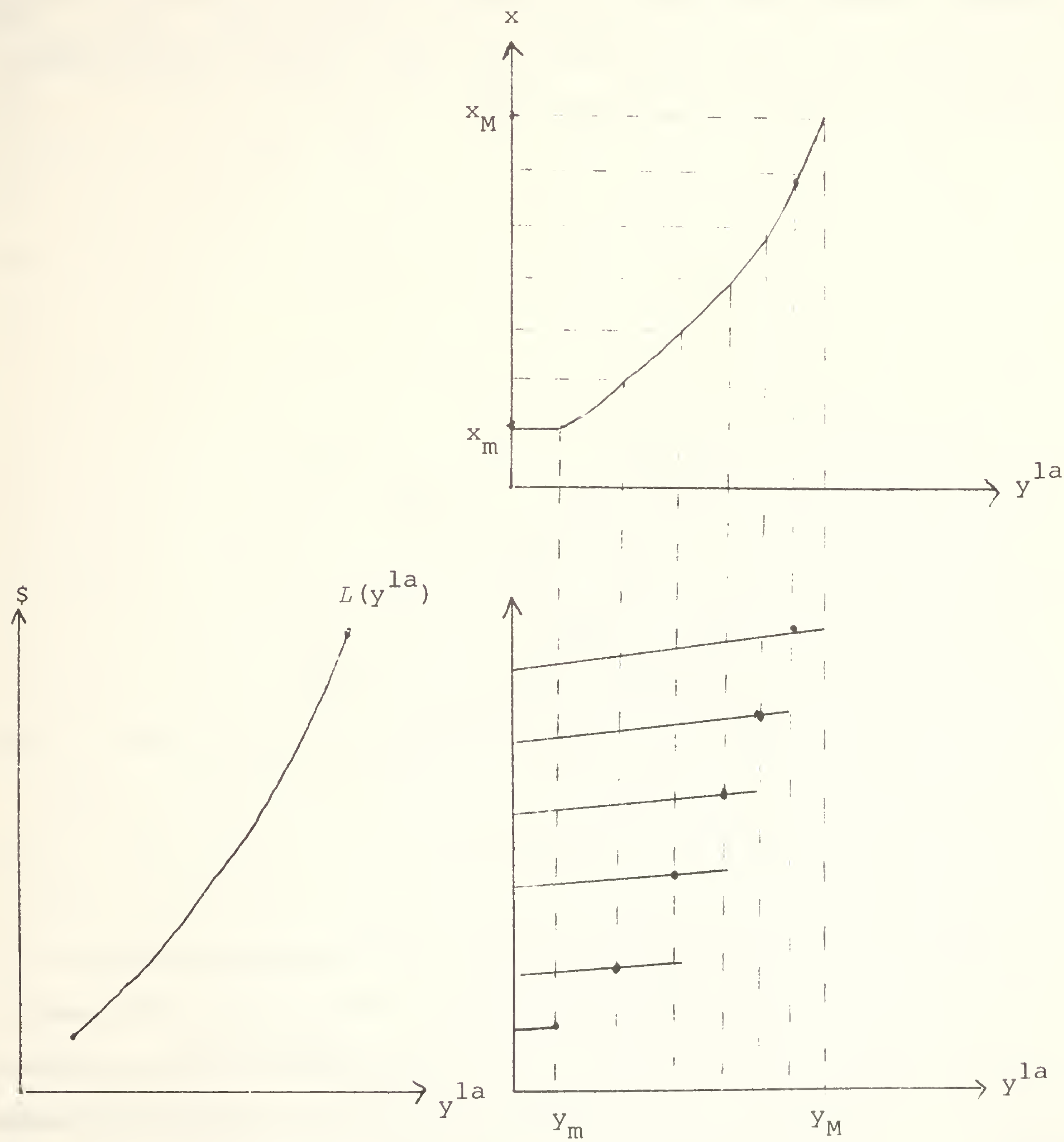

Figure 9

Combining $M(y^{la})$ and $L(y^{la})$ on a single graph and adding their coordinates yields $C'(y^{la})$, the total cost of providing health services to the NAD population directly in the MH and through CHAMPUS. We are, of course, interested in finding the level of inpatient direct care which minimizes this cost. This is accomplished graphically in Figure 10 below at $\hat{y}^{la}$.

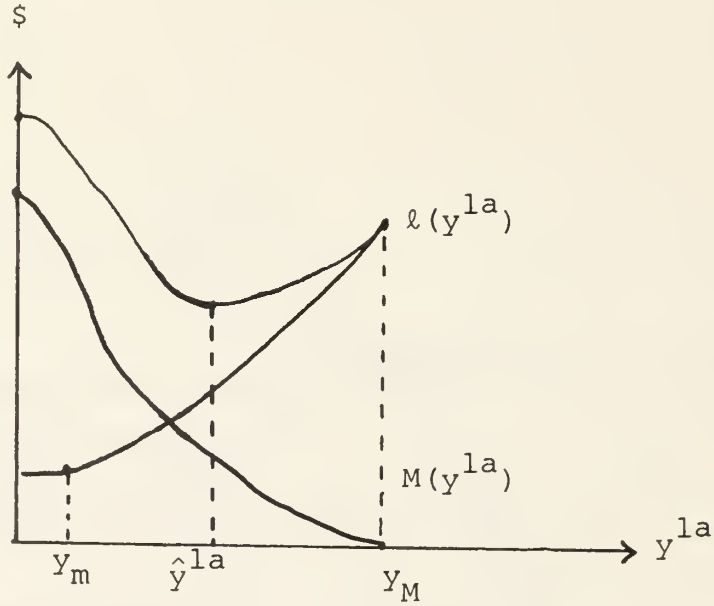

Figure 10

Emphasizing again that this particular solution is solely a function of the assumptions we've made concerning the size and operation of MH and the utilization and costliness for the alternatives and costliness of the alternatives in the private sector under CHAMPUS, it nevertheless serves to illustrate the necessity for the

careful empirical work discussed earlier.

For example, the optimal strategy in the illustrated case is to cause utilization of the MH direct care facilities by the NAD population to be $\hat{y}^{la}$. This requires an associated staffing level, $\hat{x}$ which can be found graphically by tracking backward in Figure 9 above. We also may determine the associated optimal use of CHAMPUS in Figure 8. We note that $\hat{x} > x_m$, but less than x_M. Thus, in this case it "pays" (in terms of lowest total costs) to staff at greater than the contingency levels, but still less than the full physical capacity of the hospital. This is due to the combination of the decreasing attractiveness of space available to the NAD user as the physical size of MH is approached, the constant cost situation existing in both types of facilities (MH and civilian), the fall in the marginal tendency to use CHAMPUS as NAD MH utilization rises, etc. The relative magnitudes of these and other effects determines whether the $\hat{y}^{la}$ rises or falls relative to y^{la} and must be available on a regional basis in order to ensure that the total health services budget of the military is truly minimized.

Next consider a facility that has been "staffed" at some level, say $\bar{x}$, and where the expected NAD demand $y^1(\bar{x})$ has been constrained by some exogeneous force, or has been simply less than forecast due to an erroneous prediction of the true form of $y^1(x)$. This corresponds to being "off" the $L(y^{la})$ curve as shown in Figure 11 below, at point E. Thus, having determined that $\hat{y}^{la}$ minimized total health care costs $C(y^{la})$, the decision was to "be" at point A. However, the shortfall of utilization coupled with fixed staffing yields the actual cost, utilization position at point B. Had this shortfall been foreseen (and $\bar{y}^{la}$ been such that it minimized $C(y^{la})$) the

optimal strategy would have been to staff at $\bar{x}$, not $\hat{x}$. The cost of this mistake solely in the operation of the MH is represented by the difference B-D, or $\ell(\hat{x},\bar{y}^{1a})-\ell(\bar{y}^{1a})$. If in fact we observe that this sort of thing actually occurs in various military regions (noting that a utilization above $\hat{y}^{1a}$ <u>may</u> cause the same sort of problem)*, one should not use average actual costs, $\frac{\ell(\hat{x},\bar{y}^{1a})}{\bar{y}^{1a}}$, to extrapolate for the cost of larger or smaller levels of care, since the numerator does not represent a minimum cost method of producing the given amount of care. This seems to have been a prevalent practice in the past.

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*Recall that there is usually some "utilization slack" for any given staffing level above $y^1(x)$ due to the fact that, in general, $y^1(x) + y^2 < x$. See page 10 above.

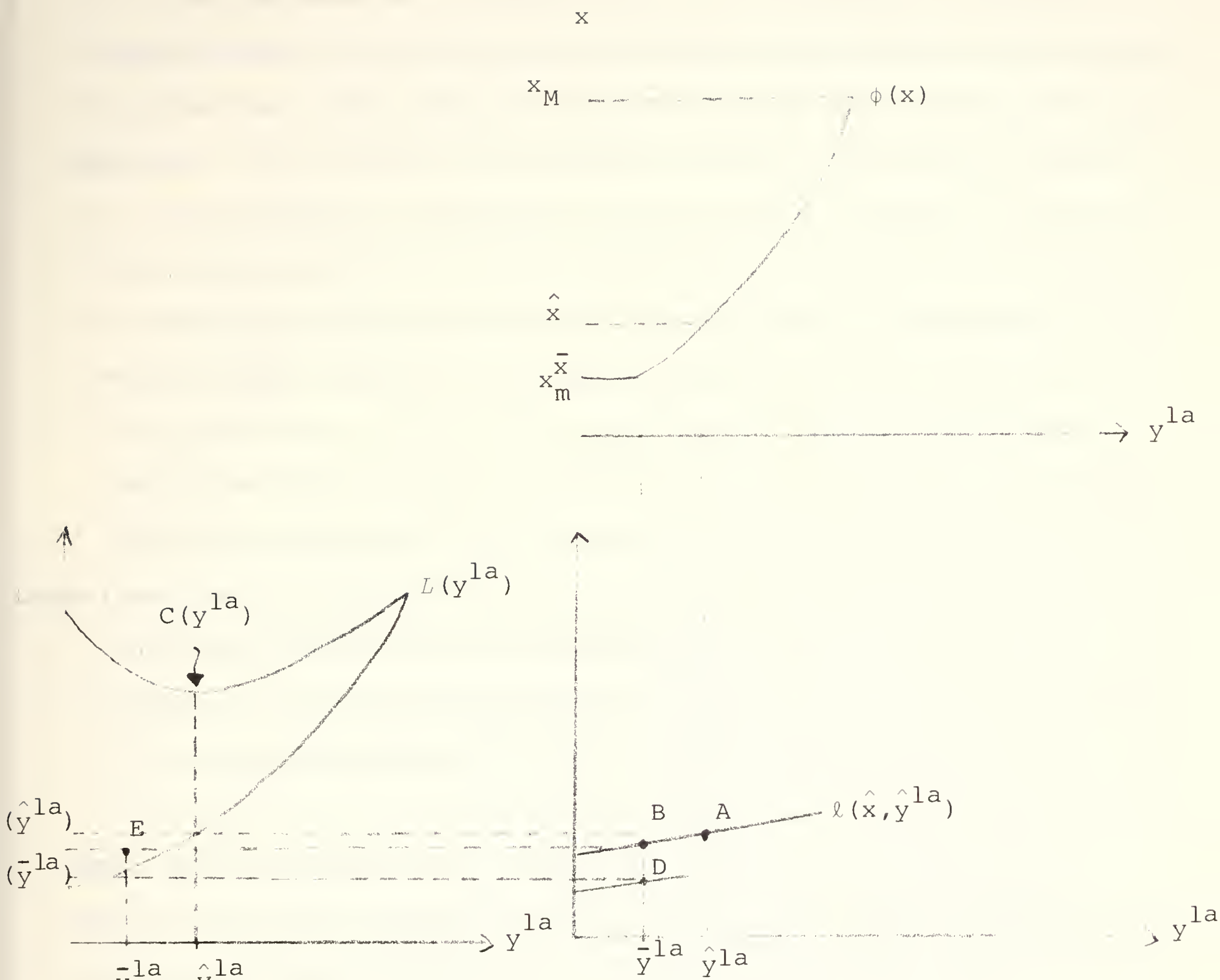
x
x_M
$\phi(x)$
$\hat{x}$
$x_m^{\bar{x}}$
y^{la}
$L(y^{la})$
$C(y^{la})$
$(\hat{y}^{la})$
$(\bar{y}^{la})$
E
B
A
D
$\ell(\hat{x},\hat{y}^{la})$
y^{la}
$\bar{y}^{la}$
$\hat{y}^{la}$
y^{la}
$\bar{y}^{la}$
$\hat{y}^{la}$

Figure 11

IV. SUMMARY AND CONCLUSIONS

A simple analytical model incorporating the most salient features of the components affecting the comparative costs of providing inpatient care to the eligible non-active duty population in either military or civilian hospitals was constructed. The model was used to indicate the four types of empirical research on a regional basis necessary to provide a truly minimum cost solution to the government's problem of providing the promised historical level of care to an ever growing number of eligible beneficiaries.

Although the present model deals specifically only with inpatient care, the general separability of inpatient and outpatient utilization decisions* indicates that a like analytical structure for the outpatient possibilities on a regional basis can be constructed with the associated direct and CHAMPUS care cost curves added to those for the inpatient sector described above in order to derive the composite optimum utilization and staffing levels for the facility and region.

Additionally, the general differential utilization by the three major subsets of NAD users of the MH** necessitates that their utilization be identified and considered. This could be done under the general model presented in this paper by noting that the NAD demand

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*That is, in the military, "contingency staffing" is in general related to the potential demand for inpatient care. Outpatient staffing and clinic size, etc. is mainly determined by the <u>actual</u> active duty complement and projected civilian utilization.

**See, for example [1] for a presentation of data which show these utilization patterns.

for care in the private sector, z^1, is a function of the allowed utilization parameter, η. That is if η decreases to one level, the dependents-of-retired, say, would be disenfranchised and would cause a shift of some amount of care to the private sector. If additionally, η further decreased to reflect a decision to shift the retired personnel themselves, then a larger shift of care to the private sector would be observed, etc. Thus, we should add to our list of required empirical work the necessity for accurate projections of the different catagories of NAD demand within the MH and the private sector.

At a time when one of the major socio-economic problems facing the nation is the demand for more equitable access to a health care delivery system which continues to be characterized by a rate of inflation greater than the overall level, and when the Surgeon's General of the three major military services are diligently searching for the least-cost method of providing the care demanded by the eligible population (which is now estimated at around 9 million people), the necessity for minimizing the number of the scarce health care inputs devoted to military-related health industry is painfully obvious. We believe the present paper will assist in the discovery of the optimal answer to the question.

APPENDIX 1

$$z^1 = z_0 - k_1 \cdot y^{1a} \qquad y^{1a} \varepsilon [0, f(x_M)]$$

$$N = N_1 + k_2 z^1 \qquad z^1 \varepsilon [z^1(x_M), z_0]$$

$$M = -k_3 N_2 + k_3 N \qquad N \varepsilon [N_2, N(z_0)]$$

$$N_2 > N_1$$

$$M = -k_3 N_2 + k_3 \{N_1 + k_2(z_0 - k_1 \cdot y^{1a})\}$$

$$M = k_3(N_1 - N_2) + k_2 \cdot k_3 \cdot z_0 - k_1 k_2 k_3 y^{1a}$$

$$M = k_3\{k_2 z_0 + (N_1 - N_2)\} - (k_1 k_2 k_3) y^{1a}$$

$$M = M_0 - k \cdot y^{1a}$$

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[1] Boeing Computer Services, "Navy Medical Care Study, Planning and Programming," August 1974, Volumes I, II, and III.

[2] Harris, Reuben T. and David Whipple, "The Perceived Quality of Health Care in the United States Military Delivery System," Human Factors in Health Care, D. C. Heath/Lexington Books, 1975.

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